Claims

I claim:

1. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

   accepting a binaural signal intended for the left and right ears of a listener; and

   processing the binaural signal to produce output signals which are suitable for reproduction through at least two loudspeakers and which cancel crosstalk in a plurality of frequency bands at an ear of the listener in a corresponding plurality of positions.

2. The method of claim 1, wherein the plurality of frequency bands and corresponding plurality of positions is substantially optimized for cancellation of crosstalk over a range of anticipated listener positions.

3. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

   accepting a binaural signal intended for the left and right ears of a listener; and

   filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, each element of the pseudoinverse of said matrix having, in each of a plurality of frequency bands, a magnitude substantially proportional to the magnitude of the transfer function between the loudspeaker and the listener ear corresponding to that element for a listener position chosen from a plurality of listener positions corresponding to the plurality of frequency bands.

4. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

   accepting a binaural signal intended for the left and right ears of a listener; and

   filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, said matrix being derived from a plurality of transfer functions between the loudspeakers and an ear of the listener in a corresponding plurality of listener positions.

5. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

processing the binaural signal to produce output signals suitable for reproduction through at least two loudspeakers and substantially optimized for cancellation of crosstalk over a range of anticipated listener positions.

6. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, the magnitude of an element of said matrix being substantially optimized for cancellation of crosstalk over a range of anticipated listener positions.

7. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, the magnitude of an element of said matrix being derived from an average of the corresponding element over a set of matrices, each matrix in said set designed to cancel crosstalk for a particular listener at a particular listener position.

8. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, the magnitude of an element of said matrix substantially being a smoothed version of the magnitude of the corresponding element of a matrix designed to cancel crosstalk.

9. The method of claim 8, wherein said smoothing is increased over frequencies at which the transfer functions between said loudspeakers and listener ear are most sensitive to listener position.

10. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, the magnitude of an element of said matrix substantially being an interpolated version of the magnitude of the corresponding element of a matrix designed to cancel crosstalk.

11. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, said matrix being the product of a mixing matrix having unit diagonal elements and a diagonal equalization matrix, wherein the magnitude of an off-diagonal element of the mixing matrix is derived from the corresponding mixing matrix element of a matrix designed to cancel crosstalk by reducing its magnitude at selected frequencies at which its magnitude is large.

12. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, said matrix being the product of a mixing matrix having unit diagonal elements and a diagonal equalization matrix, wherein the magnitude of an off-diagonal element of the mixing matrix is derived from the corresponding mixing matrix element of a matrix designed to cancel crosstalk by increasing its magnitude at selected frequencies at which its magnitude is small.

13. A method for crosstalk cancellation, which allows a listener a degree of freedom of movement, comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, said matrix being the product of a mixing matrix having unit diagonal elements and a diagonal equalization matrix, wherein the magnitude of an off-diagonal element of the mixing matrix is derived from the corresponding mixing matrix element of a matrix designed to cancel crosstalk by reducing its magnitude at selected frequencies at which the transfer function between said loudspeakers and listener ear is most sensitive to listener position.

14. A method for crosstalk canceler equalization comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

processing the binaural signal to produce output signals which are suitable for reproduction through at least two loudspeakers for a range of anticipated listener positions, said processing being designed to cancel crosstalk at an ear of said listener and including equalization filtering substantially minimizing discrepancies in equalization between a channel of the binaural signal and the sound appearing at an ear of the listener in response to said binaural channel over said range of listener positions.

15. A method for crosstalk canceler equalization comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers for a range of anticipated listener positions, said matrix being the product of a mixing matrix having unit diagonal elements and designed to cancel crosstalk at an ear of a listener, and a diagonal equalization matrix substantially minimizing discrepancies in equalization between a channel of the binaural signal and the sound appearing at an ear of the listener in response to said binaural channel over said range of listener positions.

16. A method for crosstalk canceler equalization comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, said matrix being the product of a mixing matrix having unit diagonal elements and designed to cancel crosstalk at an ear of a listener, and a diagonal equalization matrix, the magnitude of an element of said equalization matrix substantially being a smoothed version of the magnitude of the corresponding element of a crosstalk canceler equalization matrix.

17. A method for crosstalk canceler equalization comprising:

accepting a binaural signal intended for the left and right ears of a listener; and

filtering the binaural signal according to a matrix of transfer functions to produce output signals suitable for reproduction through at least two loudspeakers, said matrix being the product of a mixing matrix having unit diagonal elements and designed to cancel crosstalk at an ear of a listener, and a diagonal equalization matrix, the magnitude of an element of said equalization matrix substantially being an interpolated version of the magnitude of the corresponding element of a crosstalk canceler equalization matrix.

18. A method for crosstalk canceler equalization comprising:

accepting a binaural signal intended for the respective left and right ears of a listener;

accepting a crosscoherence function of frequency; and

processing the binaural signal to produce a crosstalk canceled output signals suitable for reproduction through loudspeakers such that the power spectrum of a channel of said canceled output in response to a two-channel random process having equal channel power spectra and channel crosscoherence equal to said crosscoherence function of frequency is substantially proportional to said power spectra.

19. The method of claim 18, wherein the step of processing includes feeding back a function of the binaural signal through a delay substantially equal to the difference in delay between two of said output signals in response to a signal applied to a channel of said binaural signal.

20. A method for crosstalk cancellation, comprising:

accepting a binaural signal intended for the respective left and right ears of a listener;

measuring a signal characteristic from the binaural signal; and

processing the binaural signal to produce a crosstalk canceled output suitable for reproduction through loudspeakers, adapting said processing to the measured signal characteristic.

21. A method for crosstalk canceler equalization, comprising:

accepting a binaural signal intended for the respective left and right ears of a listener;

measuring a signal characteristic from the binaural signal; and

processing the binaural signal to produce a crosstalk canceled output suitable for reproduction through loudspeakers, adapting said processing to the measured signal characteristic.

22. A method for crosstalk canceler equalization, comprising:

accepting a binaural signal intended for the respective left and right ears of a listener;

measuring in a frequency band of said binaural signal a crosscoherence; and

processing the binaural signal to produce a crosstalk canceled output suitable for reproduction through loudspeakers such that in said frequency band the power spectrum of a channel of said canceled output in response to a two-channel random process having equal channel power spectra and channel crosscoherence equal to said crosscoherence is substantially proportional said power spectra.